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Review

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**J. Christiaan Boudri.** *Het mechanische van de mechanica: Het krachtbegrip tussen metafysica en mechanica van Newton tot Lagrange.* xiv + 306 pp., illus., figs., bibl., index. Delft: Eburon, 1994. Dfl 59.90 (paper).

"The picture of what is perhaps the greatest revolution in the history of human thought would remain incomplete if one started after Copernicus or ended before Newton, but it would not be really enriched if one extended this era in either direction." So E. J. Dijksterhuis (in a lecture delivered in 1940) delimited the so-called Scientific Revolution, which in his view was characterized by the construction of a mechanical world picture and ended with the work of Isaac Newton. The development of the science of mechanics in the eighteenth century was considered to be not much more than the formalization of Newton's *Principia*. Few historians of science still adhere to this positivistic notion of the history of eighteenth-century mechanics. It has been shown that eighteenth-century discussions concerning the foundations of mechanics implied much more than just a working out of Newton's principles and were closely linked to theological and metaphysical issues. Now J. Christiaan Boudri, in his doctoral dissertation, argues that these eighteenth-century discussions not only were linked to but essentially *were* metaphysical discussions. There was no withering away of metaphysics, but a transformation of the metaphysical foundations of mechanics, a transformation so fundamental as to justify the conclusion that the Scientific Revolution cannot be said to have ended with Newton.

Essential for Boudri's reinterpretation of the history of eighteenth-century mechanics are two basic distinctions: between a metaphysics of substance and a metaphysics of structure, and between an explicit and an implicit metaphysics. According to Boudri, in eighteenth-century mechanics a metaphysics of substance was replaced by a metaphysics of structure. In Aristotelian and scholastic mechanics force was regarded as being transmitted from one substance to another, and in early modern science Isaac Newton and G. W. Leibniz still adhered to this metaphysics of substance. As far as the metaphysical foundations of mechanics were concerned, the Scientific Revolution had yet to begin. It was only in the work of Leonhard Euler, Jean d'Alembert, P. L. M. de Maupertuis, and J. L. Lagrange that a metaphysics of substance was replaced by a metaphysics of structure. Lagrange's *Mécanique analytique* (1788) was the synthesis of this new mechanics.

At the same time, however, the metaphysical

foundations of mechanics, explicitly discussed by Newton and Leibniz, went into hiding. By pushing further the mathematization of mechanics, d'Alembert and Lagrange hoped to free mechanics from metaphysics. But they did not succeed. Any discussion of the foundations of mechanics is a form of metaphysics, whether one likes it or not. Their effort meant only that the new (structural) metaphysics remained implicit. This explains why the fundamental changes in the metaphysical foundations of mechanics went unnoticed by nineteenth- and twentieth-century historians of science. They overlooked the replacement of a substantial by a structural metaphysics because that metaphysics as such became implicit rather than explicit.

This is but a very crude summary of Boudri's sophisticated analysis of eighteenth-century mechanics. His thesis that eighteenth-century discussions of the foundations of mechanics resulted not in the dismissal but in the transformation of metaphysics is perhaps self-evident: there can be no science without at least an implicit metaphysical point of view. What really makes Boudri's book worthwhile is the way he traces the transformation of mechanics in several eighteenth-century debates: the famous *vis viva* controversy, the equally famous discussion concerning the principle of least action, a 1779 Berlin prize contest concerning the *fundamentum virium*, and Lagrange's effort to reduce the concept of force to its purely mathematical aspect. Especially illuminating is Boudri's contrasting of the responses to the prize contest called by the Berlin Academy, which was still explicitly concerned with a metaphysics of substance but attracted none of the great mechanicians of the day, with the work of Lagrange, who by linking masses in space and time implicitly reduced force to a structural concept.

But does this prove that the Scientific Revolution cannot be said to have ended with Newton? In my view, this is not the case. Mechanics was central to the development of science as a whole in the seventeenth century, but in the eighteenth century it had lost ground to other sciences. Mechanics was more and more becoming a science just like any other. A transformation of the foundations of mechanics, important though it was for mechanics as such, no longer had the impact it would have had a century before. Without denying any of the particular theses of Boudri, it is still possible to see the history of eighteenth-century mechanics as an aftermath of the Scientific Revolution.

KLAAS VAN BERKEL